Proposed Pre-Cooling with 4-8GHz Momentum Aggregate
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It has been shown that pre-cooling the Accumulator core with both the 2-4GHz and 4-8GHz momentum cooling systems significantly decreases the longitudinal cooling time necessary to prepare for ramping to the shot lattice.   The below fast time plot shows cooling the beam after stacking has been halted before a shot setup. Take notice to the frequency width parameter, A:FRWDTH, on this plot.   From 3900 to 4500 seconds on this plot the core is only being cooled with the 2-4GHz momentum cooling.   In this configuration the cooling is very slow.   Just before 4500 seconds on this plot, the 4-8GHz momentum cooling system is turned on, so that we are cooling with both the 4-8GHz and the 2-4GHz systems.   The cooling is noticeably more efficient in this configuration. Once a frequency width of 15Hz was reached, which was around 5050 seconds on this plot, the 4-8GHz momentum cooling was turned off. Overall, we can save upwards of 30 minutes or more of cooling by using both the 2-4GHz and 4-8GHz momentum cooling systems.
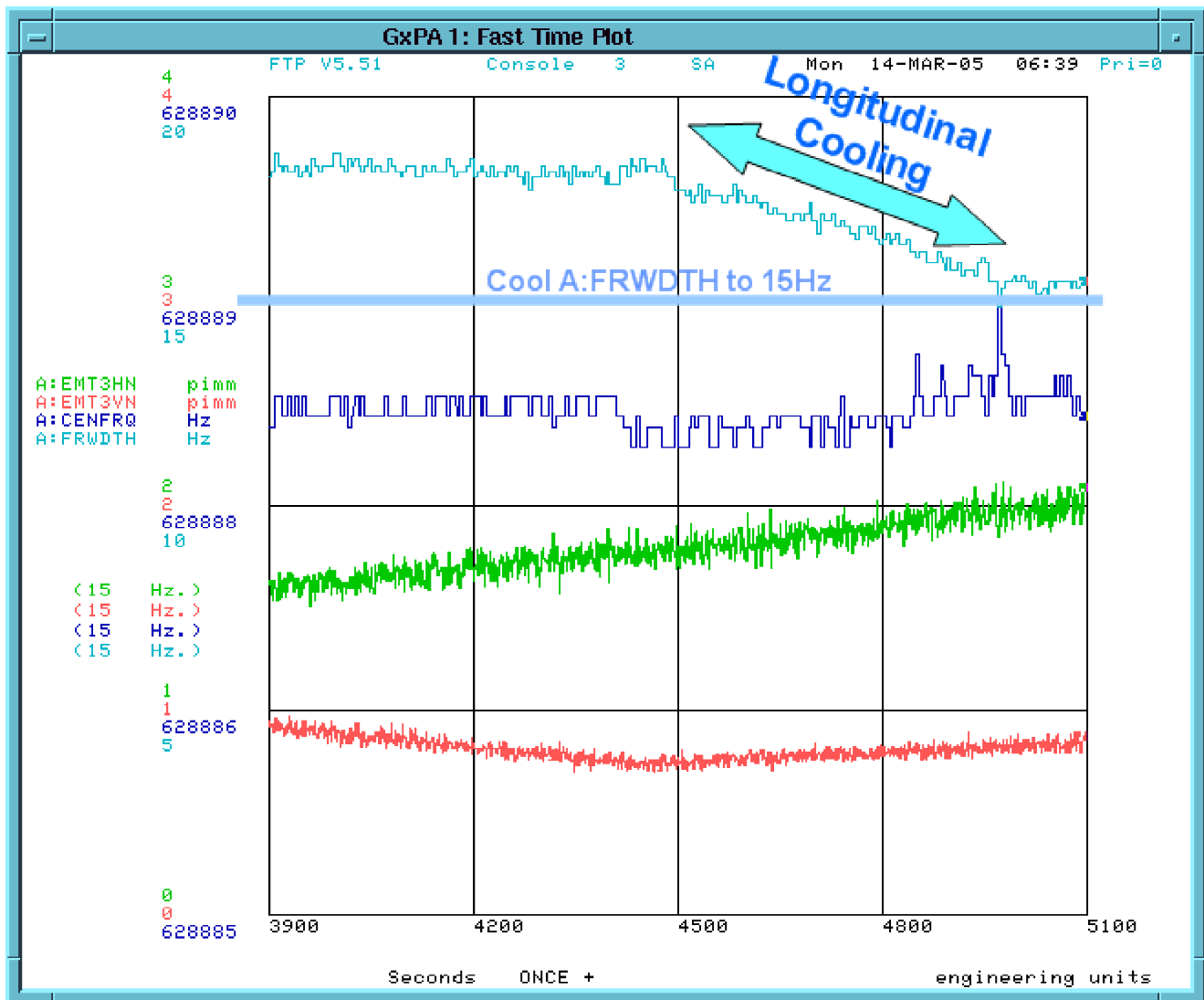

Figure 1: Example of using the 4-8GHz Momentum Cooling

For the remainder of this document we will outline the steps required to create a pre-shot cooling aggregate in

the Pbar sequencer.   This aggregate would be **optionally** started before shot setup begins to get a jump on cooling the beam.   The first portion of the aggregate would have the Pbar Sequencer Operators turn on the 4-8GHz momentum cooling at a very low level while still stacking.   The second portion of the aggregate would have operators stop stacking to more aggressively cool the core.   The last part of the aggregate would restore all settings needed to make this aggregate standalone. Upon completion of this aggregate, the **Run II Start Shot Setup** aggregate could be started, the sequencer operator could return to stacking.

A great deal of redundancy is built into this aggregate to allow it to be an "optional" aggregate. Some commands are repeated again in the **Run II Start Shot Setup** aggregate, for example.   If the VSA thermostat is changed to allow both the 2-4GHz and 4-8GHz to run at the same time, we can incorporate the second portion of this aggregate into the **Run II Start Shot Setup** aggregate, and it would not be as scary since the momentum thermostat would be able to turn off both the 2-4GHz and 4-8GHz when the desired frequency width is reached.

This document makes an attempt to show the layout of the sequencer commands needed to make this aggregate. The sequencer commands are shown in blue text in the following format.

> ::: Sequencer Command   .

Below each command are explanations and commentary on that particular sequence.   Text that would be incorporated into sequencer instructs is shown in green text.

> This is an example of text that would be used
> inside of an instruct.

The actual aggregate instructs would be made in colors that maximize their readability.   The instructs are all listed in green here simply for clarity.

Pre-Cooling Aggregate (optional):   Run this aggregate 30-60 minutes prior to the start of shot setup depending on stack size.
1. **Part 1:** This portion of the aggregate is run while we are still stacking to get a jump on the cooling with the 4-8GHz.
   - ::: INSTRUCT ###1   .
     - This instruct would contain at least the following comments.
       This aggregate is used to pre-cool the core prior to starting shot setup.
       This aggregate does not write information to the shot scrapbook, so it can be started prior to shot setup.
       The first portion of this aggregate turns on the 4-8GHz momentum while stacking.
   The goal is to gently start cooling our momentum width.
   - ::: SPECTRUM_LOAD 1 22   .
     - Sends P41 file 22 to Spectrum Analyzer #1 to allow the 4-8GHz momentum array to be aligned.

   - ::: ACKNOWLEDGE   .

- Create acknowledge that says "Start FTP on GxSA."
- ::: AUTO_PLOT {Plot Name} .
  - Starts a Fast Time Plot named {Plot Name} that contains A:EMT3HN (0-4 pi-mm-mrad), A:EMT3VN (0-4 pi-mm-mrad), A:CENFRQ (62885-628890 Hz) and A:FRWDTH (0-40 Hz) over time (0-1200 sec).
  - Our target A:FRWDTH is 20Hz.
- **:::** INSTRUCT ###2 .
  - This instruct would contain at least the following comments.
    -Go to P36 CORE_M_&_B <3>
    -The 4-8GHz momentum cooling array is located at CATV Pbar #20.
    -Adjust A:MARAYU or A:MARAYD to center the pickup over the beam.   This means make the two humps on the CATV Pbar #20 trace are equal height.
    -A negative knob makes the value of A:MARAYU or A:MARAYD more negative and moves the notch to the right.
- ::: SETIT_DEVICE A:VSAFWD =20 .
  - Set the desired frequency width.
  - As we will see below in the next command, given the current functionality of the VSA thermostat, this command is not necessary. If the thermostat is changed to allow running both the 2-4GHz and 4-8GHz at the same time, this command would be valid.
- ::: SETIT_DEVICE A:VSARST = 0 .
  - Sets the VSA to normal running.   Eventually, we want to be able to set VSARST to 5, which is momentum thermostat mode.
  - Currently the VSA momentum thermostat works with either the 2-4GHz or the 4-8GHz momentum system, but not both.   There is a threshold that can be set to what frequency width the switches from using the 2-4GHz to the 4-8GHz.   The bottom line is if VSARST is set to 5 (momentum thermostat), then either the 4-8GHz or the 2-4GHz system will be turned off by the VSA.   We would have to make modifications to allow both momentum cooling systems on at the same time.   So, in its current state, we would have to set VSARST to 0 (no thermostat) in order to use both the 2-4GHz and the 4-8GHz. The danger of doing this, is that if the Pbar Sequencer operator is not attentive to this procedure, then the cooling could drive the frequency width too narrow and lead to instabilities and lost beam.
  - So to implement pre-cooling with the current VSA functionality, we would have to have ops manually watch the frequency width and turn off the 4-8GHz, when we got to a certain level.
  - We would have to have a target table that showed our desired FRDWTH vs stack size while we were stacking?
- ::: CHECK_DEVICE A:VSARST .
  - Checks A:VSARST and displays the value in the sequencer message box.
- ::: ACKNOWLEDGE .
  - Create acknowledge that says "Start VSA on GxSC."
- ::: START_PGM SA1136 .
  - This command starts the VSA on GxSC.
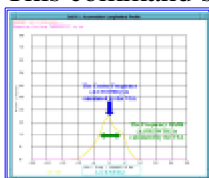
-
- ::: SETIT_DEVICE A:CMPA01 = 31.75 .

- This command sets the 4-8GHz Momentum pin attenuator (A:CMPA01) to its maximum value of 31.75dB. This ensures that there is no power on the system when it is turned on.
- ::: CTLIT_DEVICE A:CMPS01 OFF .
  - Turns on the 4-8GHz
- ::: INSTRUCT ###3 .
  - This instruct would contain at least the following comments.
    -Watch the VSA on GxSC, if it dies at anytime, it must be restarted.
    -Also watch, A:VSARST, if it goes to -1 at any point, the VSA SA must be restart.
    -From P34, lower the 4-8GHz pin attenuator until the power gets to 0.5W (P34 or A:CMTW01 + A:CMTW02).
    -Keep a constant power on the 2-4GHz momentum system.
    -Watch the VSA display on GxSC (and CATV Pbar #16). If coherent spikes show up on the display, then lower the 2-4GHz momentum power from P34 until the spikes go away.
    -Watch A:FRDWTH on the FTP. If you reach the desired frequency width turn off the 4-8GHz.
    -Once we are within 30 minutes of shot setup, continue to the next portion of this aggregate.
    -If the Pbar Sequencer operator can not dutifully watch this, finish all remaining commands in this aggregate to get back to a safe state.

2. **Part 2:** This portion of the aggregate turns off stacking to more aggressively cool with the 4-8GHz momentum.
   - ::: INSTRUCT ###4
     - This instruct would contain at least the following comments.
       -In this portion of the aggregate, we stop stacking to more aggressively cool the core with both the 2-4GHz and 4-8Ghz momentum systems.
       -Please take the Pbar beam switch.
   - ::: BEAM_SWITCH PBAR_SOURCE ON .
     - This command takes the software beam switch
   - ::: ACKNOWLEDGE .
     - Create acknowledge that says "Overwrite FTP on GxSA."
   - ::: AUTO_PLOT {Plot Name} .
     - Starts a Fast Time Plot named {Plot Name} that contains A:EMT3HN (0-4 pi-mm-mrad), A:EMT3VN (0-4 pi-mm-mrad), A:CENFRQ (62885-628890 Hz) and A:FRWDTH (0-20 Hz) over time (0-1200 sec).
     - This plot is similar to the one started in part 1 of this aggregate. The only difference is the limits on A:FRWDTH.
     - Our target A:FRWDTH will now be 15Hz.
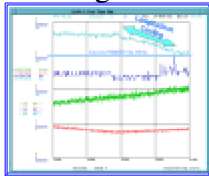
   - ::: SETIT_DEVICE A:VSAFWD =17 .
     - Set the desired frequency width to some intermediate value while we are waiting for the stacktail to be pulled over. This command is only used if we are able to run the VSA in momentum thermostat using both the 2-4GHz and 4-8GHz momentum cooling at the same time.
   - ::: INSTRUCT ###5
     - This instruct would contain at least the following comments.
       -Continue when all of the beam in the stacktail has been pulled over into the core.

-The sequencer will now turn off the stacktail.
- ::: CTLIT_DEVICE A:SPPS01 OFF   .
  - Turn off the Stacktail
- **:::** INSTRUCT ###6
  - This instruct would contain at least the following comments.
    -Look at CATV Pbar #20
    -Verify that the array is still centered on the beam.
- ::: SETIT_DEVICE A:VSAFWD =15   .
  - This command sets our desired frequency width to 15Hz.   This command is only used if we are able to run the VSA in momentum thermostat using both the 2-4GHz and 4-8GHz momentum cooling at the same time.
- **:::** INSTRUCT ###7
  - This instruct would contain at least the following comments.
    -Lower the 4-8GHz attenuator (A:CMPA01) to get the power between 1.3W and .8W (P34 or A:CMTW01 + A:CMTW02).
    -Adjust the 2-4GHz attenuator to get the power between 8W to 12W
    -Note that the 2-4GHz momentum power will fall fairly fast as the core cools, so watch the power and adjust the attenuator to keep the power in its desired range.
    -Watch the VSA display on GxSC (and CATV Pbar #16).   If coherent spikes show up on the display, then lower the 2-4GHz momentum power from P34 until the spikes go away.
    -Watch the VSA on GxSC. If it dies at anytime, it must be restarted.
    -Also watch, A:VSARST.   If it goes to -1 at any point, the VSA SA must be restart.
    -Carefully watch the Frequency Width (A:FRWDTH) on your FTP.   Once the frequency width drops to 15Hz, continue on to the next portion of the shot setup.
    -Warning!   If the beam gets much thinner than 15Hz, it may go unstable and a large portion of the stack could be lost.   If the Pbar Sequencer operator cannot closely monitor this aggregate, finish the remainder of the commands in this aggregate and

3. **Part 3:** This portion of the aggregate cleans things up to allow the start of the **Run II Start Shot Setup** aggregate.
   - ::: CTLIT_DEVICE A:CMPS01 OFF   .
     - Now that the beam has been cooled to 15Hz, the 4-8GHz momentum cooling must be turned off.
   - **:::** INSTRUCT ###8
     - This instruct would contain at least the following comments.
       - The 4-8GHz momentum system has been turned off and will remain off in the next two aggregates as you prepare to move to the shot lattice. If there is need to run the 4-8GHz in the next aggregate, then you can
         - Change A:VSARST from 5 to 0.
         - Set the pin attenuator
         - Turn on the 4-8GHz Momentum system
         - Carefully watch FRDWTH. When it reaches 15Hz again,
           - Turn off the 4-8GHz
           - Change A:VSARST back to 5.
       - At this point, you can either
         - Cancel out of this instruct and continue on to the **Run II Start Shot Setup** aggregate. Remember that the Tevatron sequencer starts the shot scrapbook chapter for the shot so don't start the next aggregate until this is done.
         - If you accidentally continued to this point before the frequency width reached

> 15Hz, go back to INSTRUCT ###4 and continue from there.
>   - If the shot setup is cancelled, simply run the two commands after this aggregate and then flip the beam switch to return to stacking.
>   - ::: BEAM_SWITCH PBAR_SOURCE ON .
>   - The software beam switch is turned back on just in case the Pbar Sequencer operator needs to go back to stacking.
>   - ::: CTLIT_DEVICE A:SPPS01 OFF .
>   - The stacktail is turned back on just in case the Pbar Sequencer operator needs to go back to stacking.

That summarizes all of the commands that would be required to make an optional standalone aggregate to pre-cool the core before shot setup.